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Audiation and its applications for intonation in beginning band

An Honors Thesis submitted in partial fulfillment of the requirements for Honors in The
College of Arts and Humanities

By
Jake G. Maine

Under the mentorship of Dr. Laura Stambaugh

ABSTRACT

Music educators take on the daunting task of teaching students a wide array of skills necessary to promote independent musicianship. Among this list of skills is the ability to play with good intonation. The theoretical basis of this study draws on the work of Edwin E. Gordon, his music learning theory, and his audiation based approach to the acquisition of musical proficiency. This study implements three separate treatments: singing with Curwen hand signs, playing with an accurate tonal model, and playing over a tonic drone to measure the effectiveness of each treatment. Participants were 7th grade band students who play flute, alto saxophone, and tenor saxophone. Students engaged in six ten-minute sessions designed around their given treatment. Post-test results showed that playing with an accurate aural model may improve intonation on alto saxophone. Teachers may benefit from providing consistent aural models for students before playing.

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Honors Director: Dr. Steven Engel

November 2021
Bachelor of Music in Music Education
Honors College
Georgia Southern University

Acknowledgements

I would like to thank Dr. Laura Stambaugh for your guidance and support through each stage of this process. Your willingness to share your knowledge and experience has been an invaluable part of my time here at Georgia Southern.

I would like to thank Dr. David Langley for your ceaseless enthusiasm and encouragement. Your positive demeanor and understanding at the beginning of the thesis process was exactly what I needed to feel motivated without becoming overwhelmed.

I would also like to thank Dr. Steven Engel and the University Honors College for teaching me the value of curiosity, commitment, and “humility before honor”. The opportunities afforded to me by the Honors College have challenged me both academically and socially. As my time on campus draws to a close, I know the skills I have learned and the friendships I have made will last a lifetime.

Audiation and its applications for intonation in beginning band

The ability to audiate is a cornerstone of independent musicianship. The term audiation was used by Edward E. Gordon in his music learning theory (Gordon, 2007). Gordon explains the phenomena of audiation as the “ability to hear and give meaning to music when sound is not physically present or may never have been physically present” (2011, p. 10).

Gordon compares the process of attaining musical proficiency to the acquisition of language. He argues that since language is learned aurally, music should be as well. While it is widely accepted that audiation and the development of aural skills are essential to the development of aspiring instrumentalists, band directors often do not implement practices that encourage student success in this area. The Gordon Institute for Music Learning breaks the development of audiation into three categories: rote before note, patterns not individual notes, and solfege (not letter names). By creating associations between notes, students can create musical meaning, the use of solfege helps to eliminate the fear of “harder keys” present in young musicians.

In chorus and orchestra classrooms, audiation is an indispensable component of instruction that emphasizes the importance of intonation by first asking students to form a mental picture of the music before performing it. Wind players have the luxury of being able to find approximate pitches using different key/valve/slide combinations, and only after years of playing do they begin to understand the importance of intonation. Gordon states “Fine musicians know when they are audiating: it occurs when ears become more important than fingers” (2007, p. 7). Music Learning Theory combines knowledge of sequential music learning, music aptitude, and audiation (Gordon, 2007). When used

correctly and routinely, it enables students to understand musical concepts such as meter, rhythm, and tonality which in turns gives them the ability to play in tune and expressively with or without notation. Conway poses an important question when she asks, “What does it mean to be ready to play an instrument?” (2003, p. 27). While this may feel vague, it cannot be overlooked. Can students develop a thorough understanding of tonality, meter, and intonation while also learning the executive skills such as embouchure, posture, and notational literacy?

The Pestalozzian ideal of sound before symbol can be found in many philosophies of music education today. While this principle is utilized in general music and choir classes, beginning band teachers often do not incorporate it into their teaching. Finding new and better ways to teach audiation in band is crucial to the profession and to me as an individual. Western music is firmly rooted in reading notated music, therefore for most students, playing anything they cannot see is very challenging. This is a significant disservice to both students and teachers as it leads to stunted musical growth that can be difficult to mend. By finding efficient methods of teaching audiation, band students can be taught to play with an advanced level of intonational maturity early on without these activities absorbing an excess amount of class time. The purpose of this study is to examine existing methods of teaching audiation and measure their effectiveness at developing intonational awareness in a beginning band setting.

Literature Review

This literature review examines the teaching of audiation, its purpose, and validity in music education.

Gordon's Music Learning Theory

Gordon proposed there is both content and context to music (2011, p. 8-12).

Content refers to tonal and rhythm patterns, and context concerns musical syntax such as tonality and meter. With this in mind, Gordon stated, “without audiation of context to serve as readiness for audiation of content, sound remains simply as sound and is not translated into music by the musical mind” (2011, p. 10). Zoltan Kodaly also created this connection between music and literacy by saying music should be read, “in the same way that an educated adult... reads a book: in silence, but imagining the sound” (2018, p. 8). Azzara agreed with Kodaly and Gordon in that musicianship is in many ways parallel to literacy. Students need to be taught how to imagine the sounds they see and the ones they wish to create before they can be expected to perform them successfully. Campbell (2020) also reaffirms the idea of musical literacy and textual literacy being one and the same: “reading is basically an auditory process that happens to have some visual steps. We don’t get meaning from text—we get it from words, and to our brains, words are sounds. Our inner voice is the bridge between sight and sound” (p. 29). I would even go so far as to compare Gordon’s Music Learning Theory to a phonics-based approach to language acquisition rather than the whole language approach.

In his book, “*Preparatory audiation, audiation, and music learning theory*”, Gordon (2001) describes eight separate and distinct types of audiation (which are not

sequential). For the purpose of this study, I will focus on the second type of audiation he describes. Type two audiation occurs when an individual interprets and performs familiar or unfamiliar music (2001). Audiation at this level requires the individual to create an accurate aural model of musical notation regarding both pitch and rhythm. Gordon breaks down his learning theory into two distinct pedagogical categories: discrimination learning and inference learning. The former is characterized by the repetition of familiar patterns, tonalities, and meters where learners are encouraged to create verbal (solfege) and symbolic association (Curwen hand signs, spatial representation) through aural/oral repetitions of exercises (2001). Figure 1 is an example of tonal discrimination learning taken from *Jump right in: The instrumental series*, a beginning instrumental method book series written by Gordon with the explicit purpose of teaching music through audiation.

Figure 1*Tonal discrimination exercises*

1) SILENTLY SING the following patterns WITH TONAL SYLLABLES.
 2) SING them ALOUD WITH TONAL SYLLABLES.
 3) Perform them on your instrument.

THE ARROW (→) POINTS TO DO.

Note. The tonal discrimination exercises above demonstrate the sequence of interval training beginning with major and minor thirds with a strong emphasis on tonality being implied by the arrow pointing to Do in each exercise.

Grunow, R. F., Gordon, E. E., & Azzara, C. D. (2001). Jump right in: The instrumental series. Gia Publications.

Figure 2*Rhythmic discrimination exercises*

I. You have heard the notated patterns below on your **Home-Study Cassette**. Read them by chanting **WITH RHYTHM SYLLABLES** and by performing them on your instrument. The patterns on the left (4/4) are **enrhythmic** (i.e., they sound the same, but look different) with the patterns on the right (C).

The numbers (4,2) indicate how many macro beats are in a measure.
The symbols (♩, ♪) indicate what kind of a note is a macro beat.

Note. Audiation applies to rhythm as well as pitch. The examples above are meant to be accompanied by audio recordings which ties directly into Gordon's sound before sight approach. Additionally, he ties meaning to symbols such as the time signature by displaying it in two different ways.

Grunow, R. F., Gordon, E. E., Azzara, C. D. (2001). Jump right in: The instrumental series. Gia Publications.

Inference learning by comparison focuses on the presentation of unfamiliar patterns, orders, tonalities, and meters requiring learners to apply skills learned through discrimination exercises.

Figure 3*Inference learning exercises*

1. Audiate one of the following melodies. (If necessary, SING INDIVIDUAL TONAL PATTERNS WITH TONAL SYLLABLES, and CHANT INDIVIDUAL RHYTHM PATTERNS WITH RHYTHM SYLLABLES. DO NOT SING THE ENTIRE MELODY WITH TONAL SYLLABLES; DO NOT CHANT THE ENTIRE MELODY WITH RHYTHM SYLLABLES.)

2. Audiate that melody while performing it silently on your instrument.

3. Perform that melody on your instrument.

NOTE: Numbers 1,2 and 3 may be performed simultaneously with all wind and percussion instruments. Numbers 4,5,6 and 7 are written for your instrument only.

① **Allegro**
f

② **Moderato**
mp *rit.*

③ **Moderato**
f

Note. The inference learning exercises above are meant to bring together the rhythmic and tonal exercises that come beforehand. From “Jump right in: the instrumental series”, by R. F. Grunow, E. E. Gordon, and C. D. Azzara, 2001. Gia Publications.

In addition to the eight *types* of audiation mentioned previously, Gordon outlines six distinct *stages* of audiation. Stage one audiation is described as momentary retention and is characterized by the ability to briefly retain short series of pitches and their durations. Stage two audiation is defined by “imitating and audiating tonal and rhythmic patterns and identifying tonal centers and macrobeats” (2001, p. 15). Stage three is more abstract and requires learners to be able to establish objective or subjective tonality and meter, meaning that the individual may be required to mentally regroup and reorganize the sounds they hear to gain tonal and rhythmic understanding. Stage four centers around

retaining essential pitches and rhythms “to clarify and make better decisions about the tonality and meter we have already recognized or identified” (2001, p. 17). Stage five requires a firm understanding of the previous four stages to be successful because this stage is where the learner recalls familiar tonalities and meters and applies them to what they are currently attempting to audiate. Gordon notes that success at this stage is almost entirely dependent on the existing musical vocabulary of the individual, “as with language, the more words we have in our vocabulary, the better we can think and communicate” (2001, p. 18). Stage six, the final stage Gordon outlines is denoted by the ability to anticipate and predict tonal and rhythmic patterns. Anticipation in this context refers to the foretelling of what will be heard in familiar music, and prediction is based on what the learner can assume comes next based on their experience.

Teaching Audiation

Audiation should not be confused with imitation. Imitation is quickly forgotten while audiation requires individuals to generate an aural model, engaging more areas of the brain than imitation alone. Gordon states, “Imitation, sometimes called inner hearing, is a product, whereas audiation is a process” (2001, p. 4) What he means by this is that imitation is possible without ascribing meaning to the pattern being imitated, but audiation requires an individual to reflect on and internalize what they have heard. Patterns taught through imitation are quickly forgotten, but the same patterns taught through audiation are assimilated into the individual’s musical vocabulary for future use.

The goal of effective educators is to encourage this mental stimulation via audiation and to push students to ascribe meaning to the music they make. Azzara notes,

“Musicianship is fundamentally based on audiation. When we audiate, we give meaning to music that we read, write, create, and improvise” (1991). Azzara’s insightful article, *“Audiation, improvisation, and music learning theory”*, outlines the difference between musical behaviors and music-related behaviors. He sheds light on the importance of an audiation based education. He states, “A musical behavior involves understanding based on audiation, music related behaviors can be described by activities such as identifying clefs or key signatures and knowing the time values of notes” (1991, 107-108). This statement addresses the divide in the classroom between declarative knowledge and procedural understanding. The acquisition of musical skill requires a delicate balance between procedural knowledge (intonation, phrasing, dynamics) and declarative knowledge (B natural is second valve/a quarter note gets one beat). If a student is musically literate and can readily provide information about a composition but cannot prescribe meaning to it through audiation and performance, they have failed to gain a musical understanding of the piece and can do nothing more than provide commentary on it. Robert Duke expresses similar views in his book *“Intelligent music teaching”* by exposing the limitations of lesson plans that focus on what repertoire students are playing rather than how they are playing it. “What we often observe are teachers working to get through a piece without stopping but without close attention to the quality of the performance.” (2019, p. 27) Getting through a piece does little for the development of procedural knowledge, replacing it instead with an excess amount of declarative knowledge that removes the opportunity for musicality and a fulfilling musical experience.

In a 2005 study seeking to integrate Gordon's ideas with the Suzuki method of violin instruction, Krigbaum states that the main problem with the development of internalized musicality is, "the mechanical and intellectual problems have taken the student's attention away from the music itself. Singing requires students to listen and to audiate before they perform, since they do not have the instrument to help them" (p. 88). By placing an instrument in the hands of a student before they have a firm understanding of basic musical principles, they are almost certain to reach cognitive overload. As a result, instead of developing critical listening skills students become mechanical button pushers.

Strings and choral directors employ various techniques to teach audiation even if they are not listed as audiation since audiation is essential to the development of pitch discrimination. Suzuki is a name that comes up often in the world of string players and refers to the Suzuki technique of learning through imitating a more experienced instructor/player. This traditional style of teaching can be summarized as the ear-to-hand playing with minimal notation used until later on. Przygocki introduces an additional step to this process by advocating for notation, resulting in an eye-to-ear-to-hand approach (2004). This interesting idea blends the theories of Suzuki and Gordon to promote musical literacy and solid intonation. In the choir classroom, solfege is the basis for building a strong inner ear. Daily interval training of increasing difficulty enables students to internalize notated music before ever hearing it performed. In the beginning orchestra classroom, singing is also an indispensable tool for improving intonation. Przygocki (2004) teaches students by singing pitch patterns, bass lines, and tonic as reference pitches.

The concept of singing in an instrumental setting to establish a strong foundation for intonation is far from a novel one. Many educators and practitioners have explored the advantages of singing in the classroom (Dalby, 1999; Denis, 2018; Gardner, 2009; Oare, 2018; Robinson, 1996). If so many educators are advocating for singing in the band room, why is it not a larger part of instruction? According to Dalby, “Singing helps students concentrate on the pitch in their minds without being led astray by the intonational characteristics of their instruments or the limitations of their technique” (1999, p. 22). By audiating and singing in the classroom, students can internalize the music they are making with good intonation before they externalize it without being hindered by technical issues. Dalby also advocates for a three-step technique of playing through a phrase on a well-tuned keyboard, having students sing it, then play it on their instrument. This listening-based approach can then be applied to notation when students are more confident in their abilities. Gordon’s Music Learning Theory has yet to be thoroughly explored in the band setting and could provide educators with additional strategies to improve the intonation of beginning band students. There is a significant gap in existing research concerning audiation and its effectiveness at improving the intonation of beginning wind players.

The research questions for this study were as follows: 1) Will a student's intonation improve when playing over a tonic drone? 2) Will providing an accurate model playing in a call and response fashion improve intonation? 3) Does singing patterns on solfege with Curwen hand signs (when possible) before playing improve intonation? 4) Can routine audiation exercises improve the pitch discrimination of young band students?

Method

Participants

Participants ($N = 3$) were seventh grade band students who played alto saxophone, tenor saxophone, and flute. Participants were in their second year of instrumental instruction at a middle school in southeast Georgia. Participants were chosen at the recommendation of the band director based on their satisfactory degree of technical proficiency on their instrument. Data collection and treatment implementation took place during band rehearsals with each session being limited to ten minutes. There were a total of six sessions per student in the fall semester.

The space in which treatments were implemented was the instrument storage room adjacent to the band room. This room housed a variety of instruments as well as two chairs and a stand for use in testing. Proximity to the band room did allow for sound from band rehearsal to bleed through, but with minimal interruption to implementation and testing. Participants were asked to individually perform the same set of excerpts, but with three different treatment methods: (a) playing over a tonic drone. (b) playing with an accurate model given on the same instrument, and (c) singing solfege with Curwen hand signs before playing.

Demographics

The demographic of the school was 77.3 % White, 13.1% African American, 4.4% Hispanic, and less than 1% respectively for Asian and Pacific islanders.

Information on the musical background of all participants can be found in Appendix A.

Materials.

Excerpts selected for this study were intended to be simple enough rhythmically and melodically that students could focus on tonal considerations without being hindered by technical ability. All the excerpts used in this study were taken directly from the *Anthology for Sight Singing* (Karpinski, 2017), a book designed to teach sight singing and ear training. The following excerpts were used: 48, 54, 72, 79, 84, 86, 92, 97, 109, 119, 124, 125, 128, 136, 142. To ensure these excerpts were appropriate for the ability level of the students, I conferred with the band director and transposed all excerpts to the key of concert B-flat. When choosing excerpts I was also mindful of instrumental ranges, choosing examples that were in an appropriate register for their instrument and ability level. To avoid extreme registers of the range appropriate for a 7th grade student, I did change the octave designation for select excerpts. The test excerpt is listed in Figure 4 below as excerpt A. The test excerpt was chosen for its comfortable range and the frequency of the pitches do (5) and mi (10) for a total of fifteen measurable data points.

Figure 4

Test excerpt and additional excerpts used

Figure 4 displays ten musical excerpts (A through J) for beginning band, all in G major (one sharp) and 3/4 time. The excerpts are arranged vertically, each starting with a letter in a box. Excerpts B through J include vocal line lyrics above the notes.

- A:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4.
- B:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Do Re Mi Mi Re Do Re Re Do Ti Do Do Ti La Ti Ti La Sol La Ti Do Do.
- C:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Do Do Re Mi Fa Sol Fa Mi Fa Mi Re Do Ti Do.
- D:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Do Do Re Mi Fa Sol La Sol Do Re Mi Fa Mi Re Do.
- E:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Do Mi Fa Sol La Sol Sol Do Sol Sol Mi Mi Re Do Re Do.
- F:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Do Re Mi Re Do Ti Do Re Do Sol Mi Re Do Re Mi Do Sol Do.
- G:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Do Ti La Sol Fa Mi Re Re Mi Fa Sol Fa Mi Re Re Do Do.
- H:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Do Sol La La Sol Sol Fa Mi Re Mi Re Do.
- I:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Sol La Sol La Sol Fa Mi Do Re Do Mi Re Do Mi Re Do Mi Re Do.
- J:** A scale starting on G4, ascending and then descending: G4-A4-B4-C5-D5-E5-F#5-G5-F#5-E5-D5-C5-B4-A4-G4. Lyrics: Do Do Sol Mi Re Do Ti La Sol La Ti Do Re Do.

The musical score consists of six staves, each with a letter marker in a box at the beginning. The staves are numbered 62, 67, 72, 81, 86, and 94. The music is written in treble clef with a key signature of one flat (B-flat). The staves contain various musical notations including whole, half, quarter, eighth, and sixteenth notes, rests, and beams. Solfège syllables are written above the notes. The syllables are: K: Do, Do Re Mi Re Do Re Re Mi Do Re Mi Fa Sol Fa Mi Re Do; L: Do Do Ti Do Re Do Re Mi Fa Mi Re Do Ti Do Re Do; M: Do Do Ti La Sol Do Re Mi Mi Mi Re Mi Mi Re Do Re Do; N: Mi Re Do Re Mi Fa Sol Fa Mi Sol Mi Fa Mi Re Do Re Mi Re Do; O: Do Sol Mi Do Re Do Re Mi Do Do Sol Mi Do Sol Fa Mi Re Do; P: Do Mi Sol Sol Mi Re Do Do Ti Do Re Do Mi Sol Sol Mi Do Mi Sol Mi Do Re Do.

Note. This version is in concert pitch for the flute participant, for the saxophones the excerpt was in the key of G (still concert B-flat). Excerpts are also marked with solfege to provide visual cues for the students singing while using Curwen hand signs.

As part of the pretest and posttest, students also participated in a pitch discrimination test. This test was designed to ascertain if a student's ability to discern the difference between two pitches at closely related frequencies. Using a sound wave

generator, students were asked to listen to Frequency 1 which was immediately followed by Frequency 2. Students were then asked to identify the second frequency as higher, lower, or the same as the first frequency.

Table 1

Pitch discrimination test

Frequency 1	Frequency 2	Cents sharp/flat
440 Hz	460 Hz	+77
440 Hz	420 Hz	-80
440 Hz	435 Hz	-20
440 Hz	455 Hz	+58
440 Hz	440 Hz	+0
440 Hz	445 Hz	+19
440 Hz	435 Hz	-19
440 Hz	450 Hz	+40

Note. Column three provides the correlating values in cents: the musical system used to measure intonation.

Procedure

All students participated in six 10-minute-long sessions which occurred twice a week. Pre and post test data were collected by allowing all students to warm up in the full band setting before coming into the testing area (instrument storage room) individually. Students then proceeded to play a few notes to get used to the room before hearing eight clicks on a metronome at 80 bpm. Each student then played through excerpt A two times.

After completing recordings, I administered the pitch discrimination test. All students were recorded using Audacity and a condenser microphone placed approximately 2 feet away from the bell/head joint of the instrument.

Treatment A (flute) consisted of the student playing over a tonic drone produced by a sound wave generator. For each example the student would begin by listening to the tonic drone (B-flat), then playing the first note of the excerpt to compare the pitch produced to the given pitch. In all excerpts the first note is either do, mi, or sol (see Figure 4). The student then played through the excerpt 3 times to maintain continuity of repetitions with the other two treatments. This process was repeated for each excerpt as time allowed.

Treatment B (alto saxophone) consisted of the student playing each excerpt with an accurate aural model presented by myself (also on alto saxophone). The student sat next to me while we looked off the same stand. For each example I would first model it while asking the student to follow along and finger through to create an aural association between what they see and what they hear. Next, we played through each example together, listening for discrepancies in pitch. Then, the student played through the excerpt once again on their own before moving on to the next excerpt as time allowed.

Treatment C (tenor saxophone) consisted of the student singing excerpts on solfege while using Curwen hand signs when possible. The student sat next to me while we looked off the same stand. Using a tone generator to establish tonic I would first model the excerpt on solfege and Curwen hand signs. Next, we would sing the excerpt together using solfege and Curwen hand signs. Then, the student would perform the excerpt once again on their own before moving on to the next excerpt as time allowed.

Data Preparation

Students were recording using Audacity and a condenser microphone positioned approximately two feet away from the bell/head joint. After recording each student two times for PreTest and PostTest, pitches were isolated in Audacity and compared to the correct frequency. After calculating the difference between recorded pitch and correct pitch, pitches played flat were notated as negative values and sharp pitches were marked as positive values. The first instance of playing concert Bb and D were used as the baseline reference pitch for each participant.

Results

Pitch Discrimination

For treatment A, the student scored 100% on both the PreTest and PostTest. For treatment B, the student scored 88% on both the PreTest and PostTest but missed an example that was flat in the PreTest and an example that was sharp in the PostTest. For treatment C, the student scored 63% on the PreTest and 88% on the PostTest. TO answer the question, 1. Did 6 sessions of audiation training improve pitch discrimination ability? I observed percent change in number of correct responses from PreTest to PostTest. In Treatment A the student scored 100% both times. In Treatment B the student scored 88% both times but missed an example that was 5 Hertz flat in the PreTest and an example that was 5 Hertz sharp in the PostTest. In Treatment C the student scored 63% in the PreTest and 88% in the PostTest.

Performance

Means and standard deviations for PreTest and PostTest performance of concert Bb can be found in Tables 2, 3, 4. Figures 5, 6, 7 also present this data set. Means and standard deviations for PreTest and PostTest performance of concert D can be found in Tables 5, 6, 7. Figures 8, 9, 10 represent this data set. Because there were no consistent trends in playing sharp or flat, no analysis was conducted on tendency to play sharp or flat.

Table 2

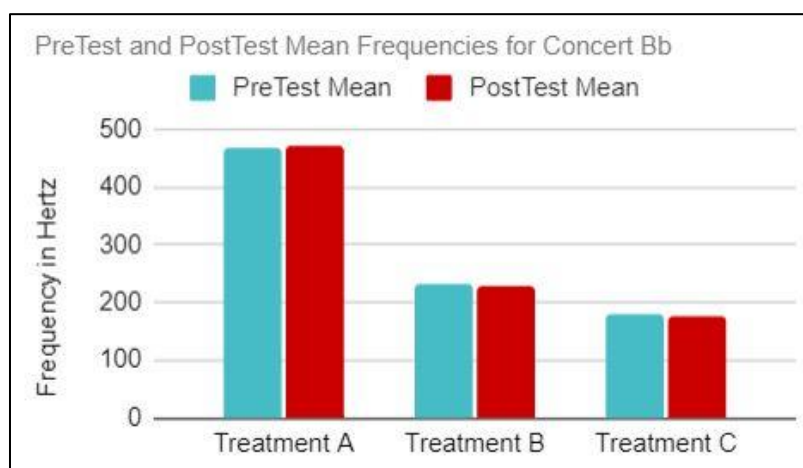
PreTest and PostTest Mean Frequencies for concert Bb

	PreTest Mean Frequency	PostTest Mean Frequency
Treatment A	467.05	472.69
Treatment B	231.76	230.42
Treatment C	178.30	177.04

Note. Frequencies above are in Hertz.

Figure 5

PreTest and PostTest Mean Frequencies for concert Bb



Note. The mean was relatively stable for all participants on concert Bb.

Table 3

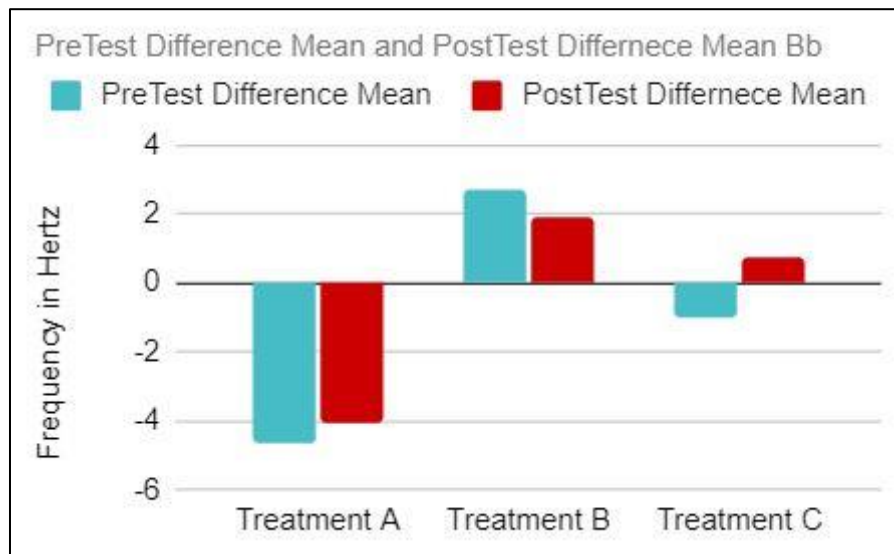
PreTest and PostTest Mean difference score from correct frequency for concert Bb

	PreTest Mean difference score	PostTest Mean difference score
Treatment A	-4.63	-4.08
Treatment B	2.67	1.92
Treatment C	-0.98	0.71

Note. Values above represent the mean Hertz away from concert Bb.

Figure 6

PreTest and PostTest Mean difference score from correct frequency for concert Bb



Note. Mean difference scores show that all three students improved from PreTest to PostTest, but this does not account for sharp/flat pitches pulling the mean difference score closer to zero.

Table 4

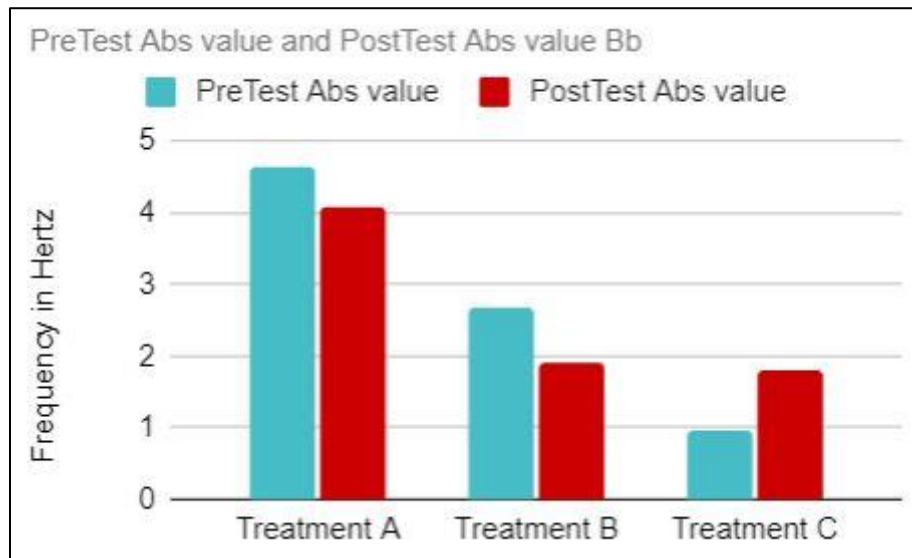
PreTest and PostTest Absolute Value difference score from correct frequency for concert Bb

	PreTest Abs value difference score	PostTest Abs value difference score
Treatment A	4.63	4.08
Treatment B	2.67	1.92
Treatment C	.98	1.82

Note. In this study absolute value is a more stable indicator of change from PreTest to PostTest.

Figure 7

PreTest and PostTest Absolute Value difference score from correct frequency for concert Bb



Note. In this study absolute value is a more stable indicator of change from PreTest to PostTest.

Table 5*PreTest and PostTest Mean Frequencies for concert D*

	PreTest Mean Frequency	PostTest Mean Frequency
Treatment A	589.59	591.22
Treatment B	291.74	290.91
Treatment C	224.08	221.52

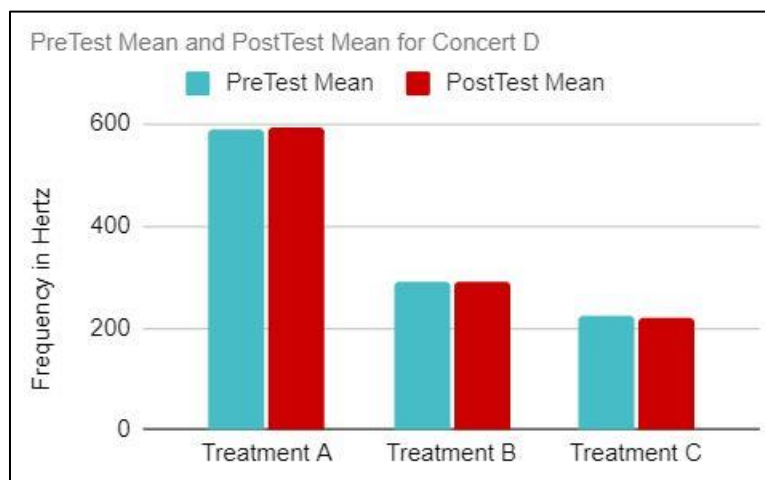
Note. Values above are listed in Hertz.**Figure 8***PreTest and PostTest Mean Frequencies for concert D**Note.* In all three Treatments concert D appears to minimally impacted.

Table 6

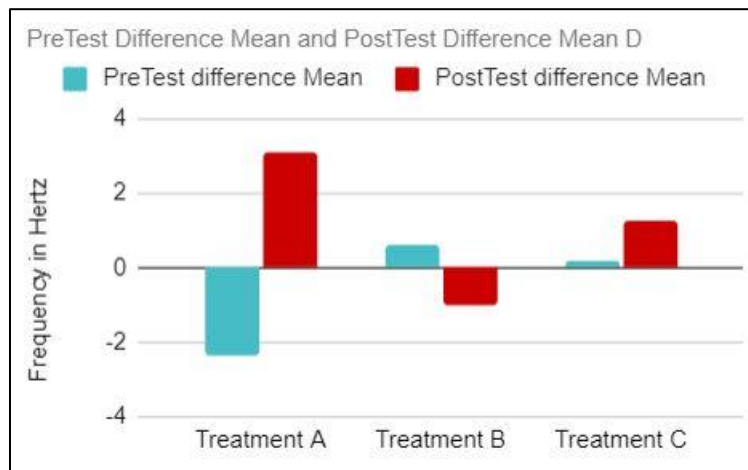
PreTest and PostTest Mean difference score from correct frequency for concert D

	PreTest Mean difference score	PostTest Mean difference score
Treatment A	-2.39	3.11
Treatment B	0.62	-0.99
Treatment C	0.19	1.27

Note. Negative values represent flat pitches and positive values represent sharp pitches.

Figure 9

PreTest and PostTest Mean difference score from correct frequency for concert D



Note. Mean difference scores for this data set do not display any trends due to inconsistencies in participants playing sharp and flat.

Table 7

PreTest and PostTest Absolute Value difference score from correct frequency for concert

D

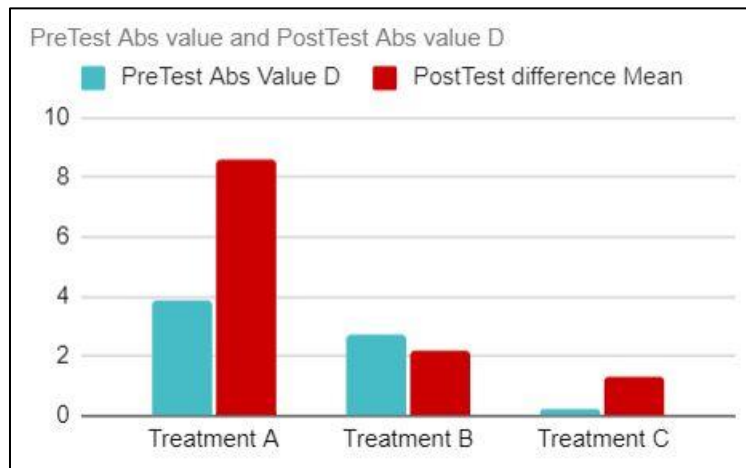
	PreTest Abs value variance	PostTest Abs value variance
Treatment A	3.89	8.63
Treatment B	2.75	2.15
Treatment C	0.19	1.27

Note. In this study absolute value is a more stable indicator of change from PreTest to PostTest.

Figure 10

PreTest and PostTest Absolute Value difference score from correct frequency for concert

D



Note. In this study absolute value is a more stable indicator of change from PreTest to PostTest.

Discussion

The purpose of this study was to determine if techniques from Gordon's Music Learning Theory can be used to improve intonation and pitch discrimination in second year woodwind students. The major findings of this study were that Treatment B may be effective at improving intonation and Treatment C may be effective at improving pitch discrimination.

Regarding the first research question, will a students intonation improve when playing over a tonic drone, result indicate that this Treatment was not effective at improving intonation and it is unclear if this treatment improved pitch discrimination as the participant scored 100% on both the PreTest and PostTest. Michael Alexander's article "*Teaching tuning to the string orchestra*", he mentions several factors that help to explain why the Treatment was ineffective. "Time studying the instrument is a more accurate measure of tuning potential than the chronological age of the student". (2008, p. 23) While the participant did have a fair amount of facility on their instrument, Alexander argues that there is no substitute for experience. He also states that a quiet atmosphere is essential and distracting noises and sounds can negatively affect a student's perception of pitch. Treatment implementation occurred in a small room adjacent to the band room which could have altered the outcome of the Treatment. While strings instruments and wind instruments produce sound in different ways, many of the concepts of intonation are transferrable (i.e., bow pressure and speed = air support and speed). Wind instruments rely on a series of keys to produce pitches close to the correct frequency which allows the player to passively interact with the music instead of actively listening to the pitches they

are producing. String instruments require the player to adjust for pitch constantly depending on factors such as humidity and temperature.

Regarding the second research question, will proving an accurate model playing in a call and response fashion improve intonation, results indicate that this Treatment is effective at improving intonation but there was no conclusive result on the ability of this Treatment to improve pitch discrimination. These findings are consistent with the study conducted by Krigbaum seeking to link audiation through Gordon's Music Learning Theory to Suzuki violin instruction. "Through the development of audiation, young violinists studying the Suzuki method can learn to comprehend the tonal and rhythmic aspects of the music they perform". (2005, p. 101)

Regarding the third research question, does singing on solfege with Curwen hand signs (when possible) before playing improve intonation, results indicate that this treatment was not effective at improving intonation, but the participant's pitch discrimination did improve. This Treatment may have been impacted by the limited time frame of the study more than the other two treatments. Asking the participant to learn Curwen hand signs while singing in addition to the executive skills related to their instrument may have resulted in cognitive overload. Denis notes that students often experience more success with intonation when learning by rote instead of notation (p. 72), perhaps if the research examples had been taught aurally the participant would have been more successful. It should also be noted that difficulties due to voice change may have impacted this Treatment as well.

Regarding the fourth research question, can routine audiation exercises improve the pitch discrimination of young band students, results indicate that singing solfege

while using Curwen hand signs may improve pitch discrimination. Walker alludes to this point as well say, “Different instrumentalists can strike a key or set down a finger to produce a pitch without auralizing the pitch. But for singing in tune, musicians must auralize correctly.” (2010, p. 2-3) Further study is needed to determine the degree to which singing can improve pitch discrimination.

Limitations

The sample size for this study was limited to 3 participants due to COVID-19 restrictions. The small sample size limited the amount of data collected and decreased the stability of the data set. Additionally, students were not asked to tune with a tuner before the PreTest, PostTest, and each session. Having a consistent tuning method could have affected the results of the study. The time constraint of completing this study in a single semester also limited the amount of measurable improvement in all Treatments. Gordon’s Music Learning Theory requires a larger time frame for holistic implementation.

Future Research

Researchers should consider exploring the efficacy of singing on solfege and using Curwen hand signs in a full band setting to determine if this method is viable outside of one-on-one sessions. This study was limited to the key of concert Bb, but it would be interesting to see if improved intonation in one key transfers to other keys as well.

Singing on solfege with Curwen hand signs was found to improve intonation but not all students are confident in their singing ability, nor do they sing with the same tone quality. Does student confidence or vocal quality affect the success of this Treatment method? This study focuses on *Type 2* audiation which is centered around reading and audiating familiar or unfamiliar music, but this narrow scope ignores the other seven types of audiation that Gordon outlines in his Music Learning Theory. Additional studies could be conducted to find additional ways to teach pitch discrimination and improve intonation through audiation.

The results of this study indicate that singing solfege with Curwen hand signs may improve pitch discrimination and playing with an accurate model may improve intonation. These findings partially align with Gordon's finding in that audiation based exercises did have a positive effect in Treatments B and C. While further study is needed in this area to determine the effects of the Treatments over a longer span of time, results suggest that playing with an accurate model and singing with Curwen hand signs may help to promote independent musicianship in second year band students.

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Appendix A

Participant's prior musical experience

	Prior musical experience	Length of time playing
Participant A (Flute)	- member of the school choir	1.5 years
Participant B (Alto saxophone)	- some musical exposure from church choir	1.5 years
Participant C (Tenor saxophone)	N/A	1.5 years